



ExMC Technology Watch

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2013 NASA Human Research Program Investigators' Workshop



Technology Watch



- Objectives:
 - To identify emerging, high-impact technologies that augment current ExMC development efforts
 - To work with academia, industry, and other government agencies in order to accelerate the development of medical care and research capabilities for the mitigation of potential health issues that could occur during space exploration missions
- Establishment of partnerships with external organizations is beneficial to technology development and furthers NASA's goal to provide a safe and healthy environment for human exploration



Overview



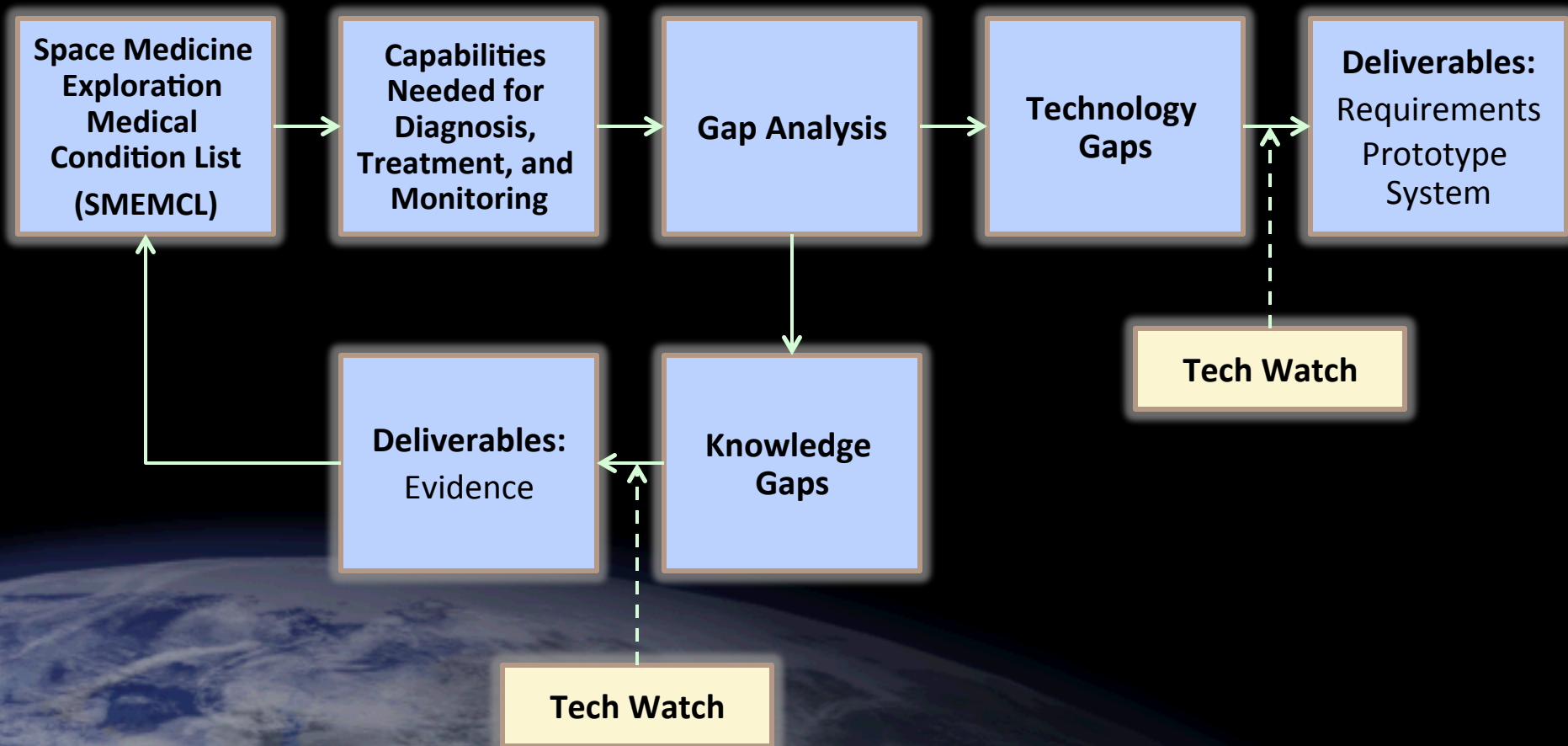
- Background
- FY12 Highlights
 - i. Gap reports
 - ii. Gap report review process
 - iii. Student/Capstone projects



Background - Overview



Technology Watch





Tech Watch Organization



Exploration Medical Capability (ExMC) Element **TECH WATCH**

Element Manager – Tammie McGrath
Deputy Element Manager – Bara Reyna
Element Scientist – Sharmi Watkins, MD
Deputy Element Scientist – Anil Menon, MD
Wiki Lead – Jack Rasbury
Technical Lead – Michael Krihak

Tech Watch Agent

GRC

Laurie Stauber

Tech Watch Agent

LaRC

Lisa Scott Carnell

Tech Watch Agent

JSC

Victor Hurst

Tech Watch Agent

ARC

Michael Krihak

Gap Owners

Gap 4.02 – B. Thompson
Gap 4.04 – S. Olson
Gap 4.06 – A. Weaver
Gap 4.09 – J. McQuillen
Gap 4.12 – J. McQuillen
Gap 4.14/4.15 – J. Zoldak
Gap 4.27 - TBD

Gap Owners

Gap 4.26 – L. Scott Carnell

Gap Owners

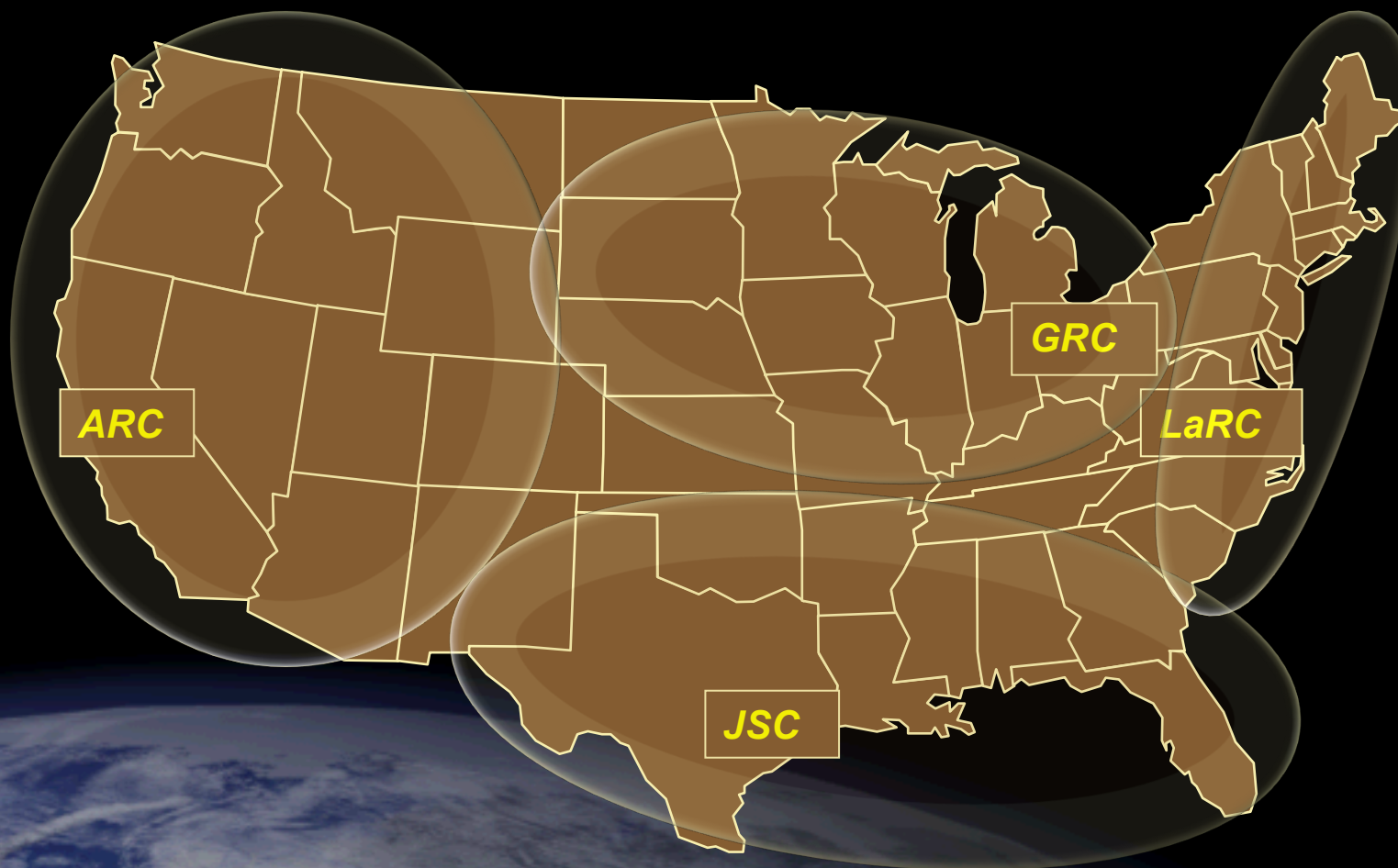
Gap 1.01/1.03 – R. Shah
Gap 2.01 – D. Butler
Gap 2.02, 4.24 – A. Menon
Gap 3.01, 4.01 – V. Hurst
Gap 4.03/4.08 – E. Kerstman
Gap 4.11 – M. Urbina
Gap 4.13, 4.22 – R. Shah
Gap 4.17 – D. Chin
Gap 5.01 – L. Best

Gap Owners

Gap 4.05 – M. Krihak
Gap 4.19 – A. Katterhagen
Gap 4.21 – A. Katterhagen
Gap 4.23 – M. Krihak



Regional Distribution





Gap Reports



Gap Report Content (Public Domain)

- Each Gap Report contains:
 - Relevant medical conditions
 - Summary of evidence
 - Typically refers to prevention, diagnosis and treatment
 - References
- Gap reports reviewed annually
 - Structured, peer-reviewed process
- Gap reports are publicly available:
 - <http://humanresearchwiki.jsc.nasa.gov>
 - <http://humanresearchwiki.jsc.nasa.gov/exmc> (collaboration side)



Gap Report Review

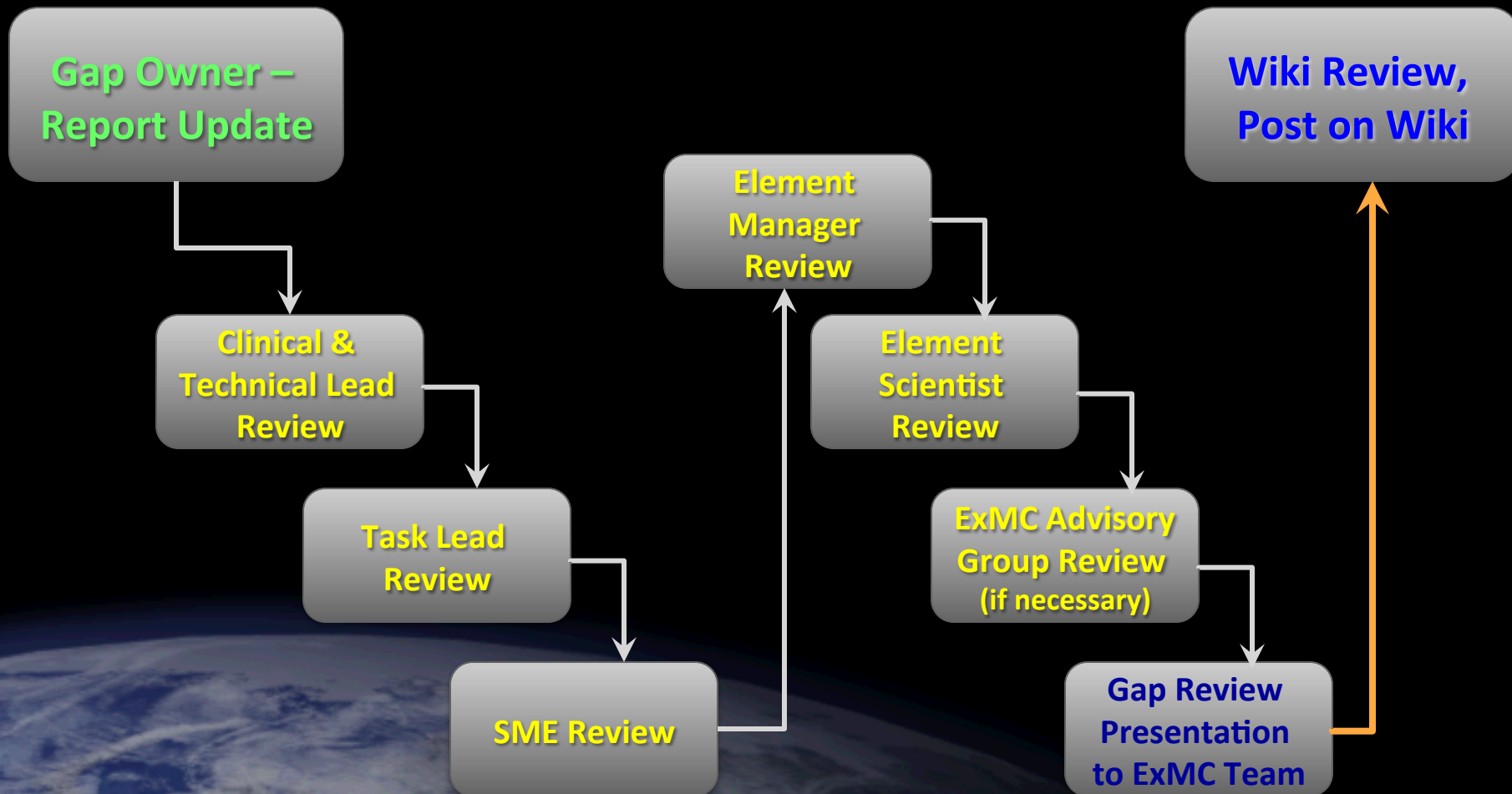


Annual Revision Focus Areas:

- Gap title
- Update medical evidence
- Interim stages for gap closure and metrics (internal)
- Approach for gap closure (internal)
- Update present state of technology
- Target schedule for closure (internal)
- Update related Tech Watch summary
- Update related student work summary
- Schedule (internal)



Gap Report Review Process



SME – Subject Matter Expert



Student Projects



Student Projects

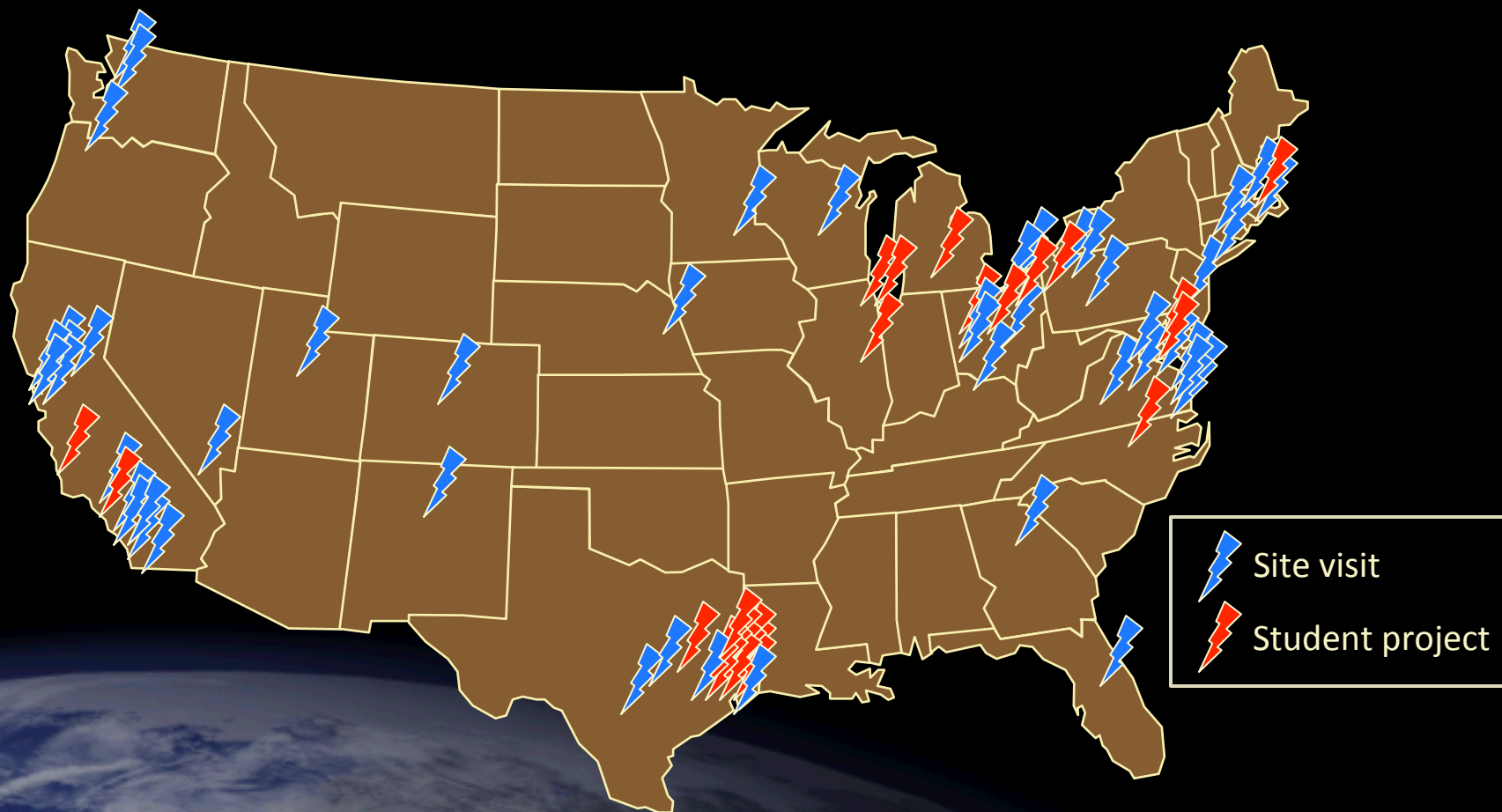


FY12 Goal: Improve the efficiency of site visits

- Evaluate synergies through telecommunications first
 - Provide the point-of-contact with ExMC Gaps
- Determine whether or not a site visit is in the best interests
 - Obtain approval through Element management
- Identify appropriate personnel and laboratories to visit
- Provide a trip report to ExMC Tech Watch project
- *Develop targeted student project(s) that address specific gap needs*



Student Projects





Tech Watch Accomplishments



General Highlights from FY12

- Joint-effort with HHC on an in-flight lab analysis capability
 - Findings through our Tech Watch process fed into the HHC development activity.
 - Several joint visits or telecons: DNA Medicine Institute, Nanomix, Rice University, OPKO, Philips, Biocartis
- Strategic collaborations/leveraging opportunities
 - Federal: DTRA, DARPA, Federal Laboratory Consortium
 - Private sector: IBM, GE
 - Research institutions:
 - Cleveland Clinic
 - Houston Technology Center (HTC) and Regional Centers of Innovation & Commercialization
 - Texas Medical Center's National Center for Human Performance



Tech Watch Accomplishments



General Highlights from FY12 (continued)

- Published Exploration Medical Capabilities *agency tech need* article in NASA Tech Briefs Magazine February 2012 issue
- Revisions of gap report and review process
- ExMC Gap brochure revision
- 15+ gap reports completed and available on the public wiki link:

<http://humanresearchwiki.jsc.nasa.gov>



ExMC Gap Brochure



National Aeronautics and Space Administration

Exploration Medical Capability Gaps

During long-duration exploration missions beyond low Earth orbit, the crew will need medical capabilities to diagnose and treat disease as well as for maintaining their health. The Exploration Medical Capability Element develops medical technologies, medical informatics, and clinical capabilities for different levels of care during space missions.

Ensuring the health, safety, and effective performance of astronauts is critical to the human exploration of space. NASA Glenn Research Center's Human Research Program (HRP) plays a vital role in providing solutions to critical problems that place human exploration missions and their crews at risk. Glenn's efforts are accomplished in support of the Johnson Space Center, which leads NASA's HRP.

NASA is looking for Federal laboratory, academia, or industry partners to collaborate with them on the HRP Exploration Medical Capability Gaps.

Any technology addressing these needs must be compatible with general space flight restrictions on mass, volume, emitted ionizing radiation, and electromagnetic interference.

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Bioscience and Technology Branch
NASA Glenn Research Center
216-443-2820
laurel.j.stauber@nasa.gov



Crewmember wearing the Treadmill Harness during an exercise session.



Astronaut/aquonaut apply a net with electrodes for an electroencephalogram (EEG) study as part of the ninth NASA Extreme Environment Mission Operations (NEEMO).



Crewmember works with the Portable Pulmonary Function System (PPFS) hardware freely floating in the Destiny Laboratory.



Crewmember centrifuges blood samples for a nutrition project during Increment 15.



human research program

www.nasa.gov

Exploration Medical Capability Gaps—Areas To Be Investigated

- 1.01 Inadequate information on preflight medical screening capabilities for exploration class missions
- 1.03 Inadequate information on the individual susceptibility to hypobaric environments (e.g., 7.2 psi lunar habitat) (CLOSED)
- 2.01 We do not know the quantified mission and crew health consequences due to medical events for exploration class missions
- 2.02 We do not know the quantified crew health and mission impacts of including a physician crew medical officer on exploration missions
- 3.01 We do not know the optimal training methods for in-flight medical conditions identified on the Space Medicine Exploration Medical Condition List taking into account the Crew Medical Officer's clinical background
- 3.02 Lack of knowledge about the current state of the art in telemonitoring/telemedicine as a tool for assisting crewmembers to diagnose and treat medical conditions that occur in space flight (CLOSED)
- 3.03 Inadequate information on capabilities for in-flight screening and diagnosis of conditions on the Space Medicine Exploration Medical Condition List
- 4.01 Lack of guided medical procedure system that integrates with medical hardware
- 4.02 Limited noninvasive diagnostic imaging capability and techniques to diagnose conditions on the Space Medicine Exploration Medical Condition List
- 4.03 Limited capability to treat back/neck pain and injuries in the space flight environment
- 4.04 We do not know what technologies can be used to provide supplemental oxygen to ill crewmembers from onset of illness through landing and recovery and also minimize the local and cabin oxygen buildup to avoid increasing the risk of fire.
- 4.05 Lack of minimally invasive in-flight laboratory capabilities with limited consumables required for diagnosing identified Exploration Medical Conditions
- 4.06 Limited capability to stabilize and treat bone fractures
- 4.07 Limited wound care capability to improve healing following wound closure
- 4.08 Limited capability to treat muscle, ligament, and tendon injuries
- 4.09 Lack of medical suction and fluid containment capability for chest tube and airway management in partial gravity and microgravity environments
- 4.10 Lack of rapid vascular access capability for space flight (CLOSED)
- 4.11 Limited dental care capabilities
- 4.12 Lack of in situ intravenous (IV) fluid generation and resource optimization capability
- 4.13 Limited capability to diagnose and treat a renal stone during an exploration mission
- 4.14 Lack of efficient medical consumable inventory tracking system that provides data on overall usage and usage rate and integrates securely with vehicle inventory management system
- 4.15 Lack of medication usage tracking system that includes automatic time stamping and crew identification
- 4.16 Lack of technique or procedure to draw injectable medication into a syringe without bubble formation or bubble removal prior to medication delivery (CLOSED)
- 4.17 Lack of adequate protection for medications to preserve stability and shelf-life in exploration class missions
- 4.19 Limited biomedical sensing capabilities for intravascular activities (such as performing periodic clinical status evaluations and contingency medical monitoring)
- 4.20 Lack of a system to manage medical data collected from the patient in space flight that integrates with ground operations (MERGED WITH ExMC 5.01)
- 4.21 Limited eye wash capability to treat chemical eye exposure in partial gravity and microgravity environments
- 4.22 Limited capability to diagnose and treat radiation sickness
- 4.23 Limited capability to auscultate internal sounds of the body in a noisy, space flight environment
- 4.24 Lack of knowledge regarding the treatment of conditions on the Space Medicine Exploration Medical Condition List in remote, resource poor environments
- 4.25 Lack of capability to deliver medication to a crewmember in a pressurized suit
- 4.26 Limited capability to diagnose and treat pulmonary or systemic disease due to nonterrestrial dust exposure
- 4.27 Limited capability to sterilize medical equipment in space flight
- 5.01 Lack of end-to-end medical data management infrastructure for exploration class missions

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Tech Watch Accomplishments



Student Project Highlights from FY12

- 20+ student projects
 - Topic area examples: chemical eye wash, assisted medical procedures, auscultation, laboratory analysis
 - Contributions to element: provided assistance in gap closure, ground analog testing protocols, collation of information/data for gaps, engineering design
 - Significant academic contributions:
 - Texas A&M, U. Michigan, UCLA, Johns Hopkins University
- Participated in 2012 RASC-AL (Revolutionary Aerospace Systems Concepts – Academic Linkage)
 - Concepts for nanoprobes developed by Washington University



Summary



- Exploration Medical Capability (ExMC) is charged with reducing the “Risk of Unacceptable Health and Mission Outcomes Due to Limitations of In-Flight Medical Capabilities”
 - The ExMC charter is to utilize technologies and informatics that address evidence-based medical conditions.
- Tech Watch was active in developing strategic collaborations with academia, federal laboratories and the private sector.
- Multiple senior projects were developed to address many of the ExMC technology and knowledge gaps.
- Tech Watch is continually improving internal capability to maintain database and track technologies.